

Science 10

Motion

Units

- A unit is added to every measurement to describe the measurement.

Ex.

- 100 cm describes a measured length.
- 65 L describes a measured volume.
- 12.4 hours describes a measured time.
- 0.011 kg describes a measured mass.

Units

- In Canada we use the metric (SI) system.
- The metric (SI) is a system designed to keep numbers small by converting to similar units by factors of 10.
- Prefixes are added in front of a base unit to describe how many factors of 10 the unit has changed.

Units

- Base units of measurement are generally described by one letter.
 - m- metre (length)
 - s- second (time)
 - g- gram (mass) *The base unit for mass is actually the kg (kilogram)
 - L- litre (volume)

Units

- Prefixes

Kilo	hecto	deca	base	deci	centi	milli
(k)	(h)	(da)		(d)	(c)	(m)

- Prefixes are added to the front of any base unit.

Ex. mm, cm, dm, m, dam, hm, km

Converting units

- There are 2 methods to convert units
 1. Step Method- count the number of places to move the decimal.
 2. Dimensional Analysis- multiplication by equivalent fractions of 1.

Converting Units

- Step method-
 - Move the decimal the same number of spaces and direction as the distance in between prefixes.

Kilo	hecto	deca	base	deci	centi	milli
(k)	(h)	(da)		(d)	(c)	(m)

Ex₁ Convert 34.56 cm into m

Ex₂ Convert 21.0 kg into g

Converting Units

- Dimensional Analysis-
 - Multiply the measurement by a fraction that equals 1
 - The fraction will contain the old unit and the new unit.
 - The fraction must cancel out the old unit. (follow the rule that tops and bottoms cancel out)

Kilo	hecto	deca	base	deci	centi	milli
(k)	(h)	(da)		(d)	(c)	(m)

Complete the following examples using dimensional analysis.

Ex₃ Convert 34.56 cm into m.

Ex₄ Convert 21.0 kg into g.

Ex₅ Convert 15.0 m/s into km/h.

Ex₆ Convert 80.0 km/h into m/s.

Defined Equations

- Relationships between variables can be expressed using words, pictures, graphs or mathematical equations.
 - A defined equations is a mathematical expression of the relationship between variables
- Ex. Mass and Energy are related by the speed of light

$$E = mc^2$$

Defined Equations

- Defined equations can be manipulated to solve for any of the variables.
 - We use the same principles from math.
- There are 2 rules that must be followed to isolate a variable.
 1. It must be alone
 2. It must be on top (numerator)

Solve $E = mc^2$ for m

m must be isolated

$$\frac{E}{c^2} = \frac{mc^2}{c^2}$$

Divide both sides
by c^2

m is already on top so we will not touch m . We have to isolate m by moving c^2 to the other side.

Ex₁ Solve $d = m/v$
for v

v is on the bottom so we need to move v first and then isolate.

1. Multiply by v on both sides
2. Divide by d on both sides

Speed

- The distance travelled divided by the amount of time.
 - How fast something is moving.

$$v = \frac{\Delta d}{\Delta t}$$

- Speed is measured in $\frac{m}{s}$

Speed

- You can look at speed in 3 different ways
 - Average- the speed over the whole trip.
 - Total distance divided by total time.
 - Instantaneous- the speed at one point in the trip.
 - Looking at the speedometer.
 - Constant- the speed remains the same over a period of time.(uniform motion)
 - Cruise control.

Calculations for speed

- Using the formula, $v = d/t$, we can make some mathematical calculations about speed.
 - Follow the same 3 steps to solve every problem.
 - Identify your givens and unknowns.
 - Identify the defined equation and isolate for the unknown variable.
 - Solve the equation using proper significant figures and units.

A trip to Calgary is 758 km. If you were to complete the trip in 7.25 h, what was your speed?

Givens	Formula	Solve
$d = 758 \text{ km}$	$v = \frac{d}{t}$	$v = \frac{758 \text{ km}}{7.25 \text{ h}}$
$t = 7.25 \text{ h}$		
$v = ?$		$v = 105 \frac{\text{km}}{\text{h}}$

What type of speed did we calculate in the previous problem?

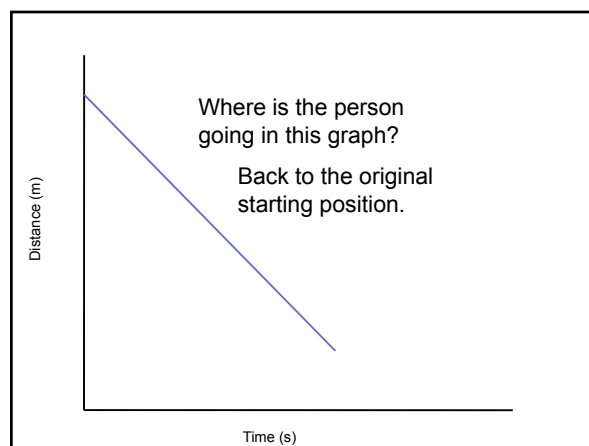
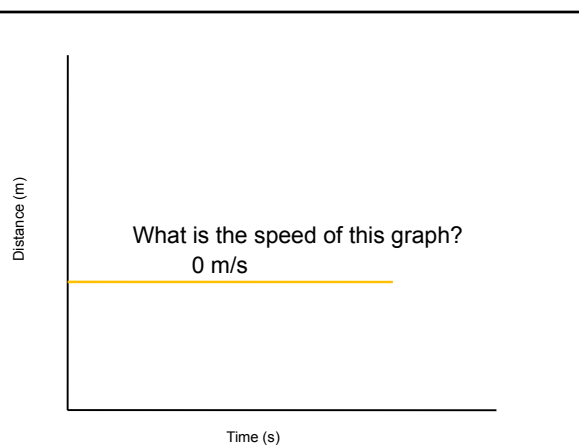
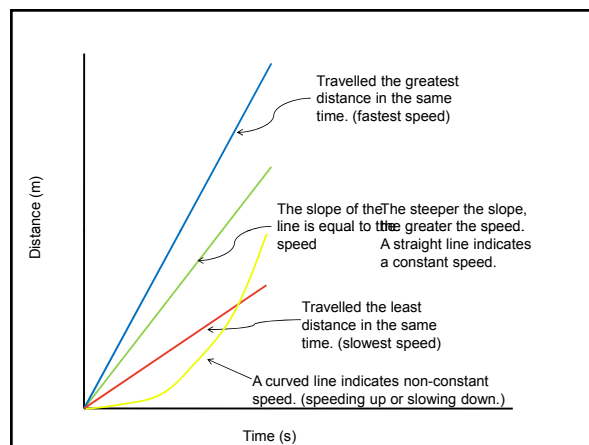
Average speed

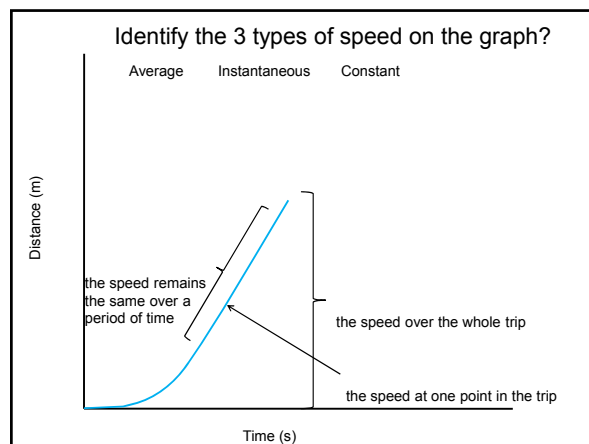
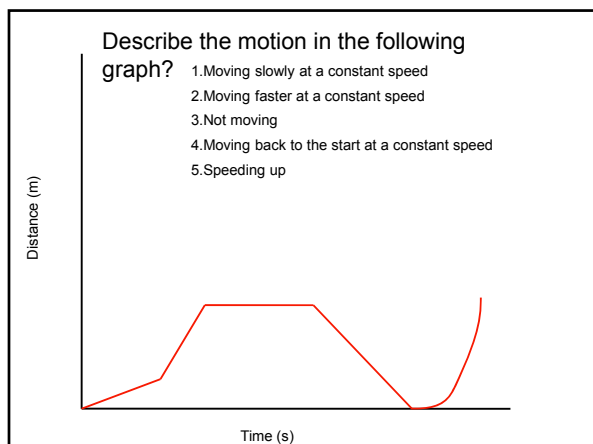
If someone is travelling at a constant speed of 40.0 km/h, how far would they travel in 32.4 min?

<u>Givens</u>	<u>Formula</u>	<u>Solve</u>
$d = ?$	$v = \frac{d}{t}$	$d = 40.0 \frac{\text{km}}{\text{h}} (0.54 \text{ h})$
$t = 32.4 \text{ min}$	$d = v t$	$d = 21.6 \text{ km}$
$v = 40.0 \frac{\text{km}}{\text{h}}$		
	$32.4 \text{ min} \cdot \frac{1 \text{ h}}{60 \text{ min}} = 0.540 \text{ h}$	

Representing Speed Graphically

- We can represent speed with words (fast, slow), numbers (32 km/h) and we can also represent it visually with a graph.
 - Speed is represented on a distance vs. time graph.
 - The slope of the graph is the speed.





Acceleration

- The change in speed by the amount of time.
 - How quickly something is speeding up (or slowing down)

$$a = \frac{\Delta v}{\Delta t}$$

- Acceleration is measured in $\frac{m}{s^2}$

Acceleration

- You can look at 2 types of acceleration.
 - Average- the acceleration over the whole time period.
 - The change in speed over time.
 - Constant- the acceleration remains the same over a long period of time.

Calculations for acceleration

- Using the formula, $a = \Delta v / \Delta t$, we can make some mathematical calculations about acceleration.
 - 'Δ' means change, Δv means change in speed
 - $\Delta v = v_{\text{final}} - v_{\text{initial}}$
- Or
- $\Delta v = v_2 - v_1$

A person on their bike changes their speed from 10.0 m/s to 15.0 m/s in 15.2 s. What is the acceleration of the bike?

Givens	Formula	Solve
$\Delta v = 15.0 \text{ m/s} - 10.0 \text{ m/s}$ $= 5.0 \text{ m/s}$	$a = \frac{\Delta v}{\Delta t}$	$a = \frac{5.0 \text{ m/s}}{15.2 \text{ s}}$
$\Delta t = 15.2 \text{ s}$ $a = ?$		$a = 0.33 \frac{m}{s^2}$

A car is traveling down the road when they see an obstruction. The person accelerates at -3.2 m/s^2 for 5.0 s until they stop. How fast was the car moving?

Givens	Formula	Solve
$v_1 = ?$	$a = \frac{v_2 - v_1}{\Delta t}$	$v_1 = 0 \text{ m/s} - (-3.2 \text{ m/s}^2) 5.0 \text{ s}$
$v_2 = 0 \text{ m/s}$		
$\Delta t = 5.0 \text{ s}$		
$a = -3.2 \text{ m/s}^2$	$v_1 = v_2 - a\Delta t$	$v_1 = 16 \text{ m/s}$

Representing Acceleration Graphically

- We can represent acceleration with words (speeding up, slowing down), numbers (9.8 m/s^2) and we can also represent it visually with a graph.
 - Acceleration is represented on a speed vs. time graph.
 - The slope of the graph is the acceleration.
 - The area under the graph represents the distance travelled

